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Robust and inexpensive microsubstrates for molecular self- assembly

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Controlled design of nanostructures by epitaxial growth provides, by use of reactive surfaces, the ability to generate low dimensional materials with tunable features [1-3]. However, the most promising single-crystal metal surfaces, such as the low-index facets of silver, are too costly for repeated trials/failures of growth experiments and eventual scale-up. To address this challenge, we examine the use of inexpensive silicon wafers to provide an alternative to alleviate the cost and enable rapid prototyping of growth experiments.

We describe the growth and characterization of 10s of nanometre to 10 micron-scale with heights ranging from 100-200 nm islands created by depositing Ag onto Si(111) at elevated temperatures. By varying the surface coverage of Ag we are able to produce and control the distribution of Ag(111) and/or Ag(100) single crystal islands. These were examined using scanning tunnelling microscopy (STM), X- ray diffraction (XRD), helium ion microscopy (HIM), and atomic force microscopy (AFM). The formation of 3D islands with orientations of either (111) or (100) was confirmed by STM and XRD analysis (Figure 1 and 2). Rietveld refinement was performed for the obtained XRD data to get a quantitative indication of the island distribution on the surface. Results suggest a preference towards the formation of Ag(111) islands at low coverage, with a tipping towards Ag(100) islands as the coverage is increased.

As these islands manifest as tiny single crystals of elemental Ag, they can be ideally used as low-cost or disposable substrates for scanning probe experiments; we demonstrate this by comparing absorption and thermal behavior of 1,3,5-benzenetricarboxylic acid (TMA) molecules on the islands and noting identical behavior and reactivity to experiments performed on Ag single-crystal counterparts. These experiments provide an economical and practical method for studying molecular adsorption on two distinct microsubstrates at the same time while under identical experimental conditions.

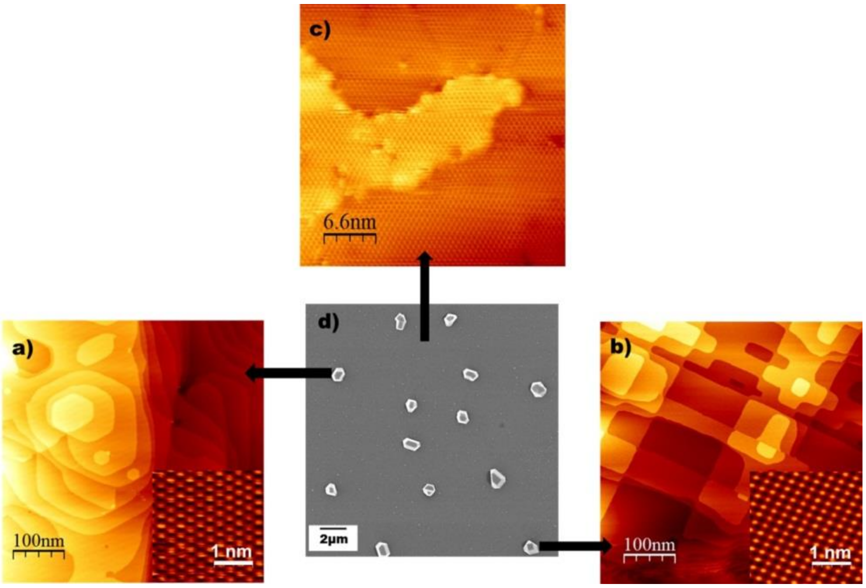

Figure 1. STM images ofdifferent morphologies of Ag islands a) wide scan STM image showing the morphology of Ag(111) island and inset showing atomic resolution of Ag(111), b) wide scan STM image showing morphology of Ag(100) island and inset showing atomic resolution of Ag(100), c) STM image $\sqrt{3}\times\sqrt{3}$ reconstruction at the interface at the Ag and d) HIM image of islands on Si(111) surface

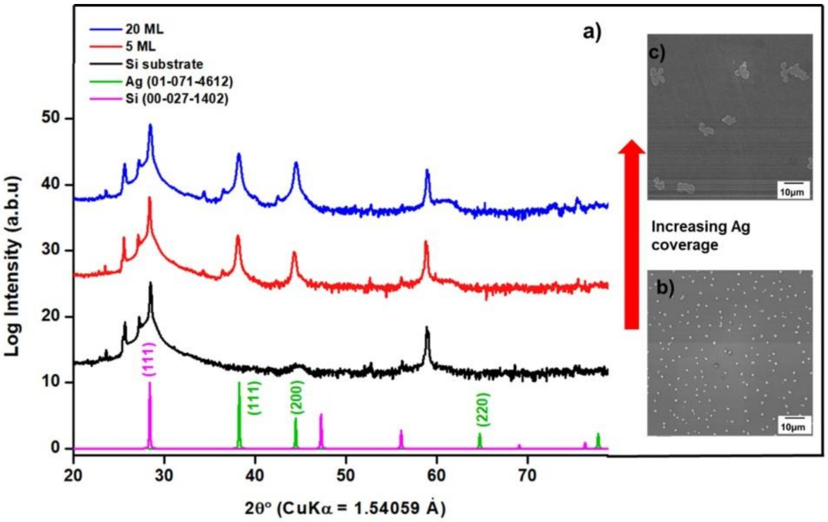

Figure 2. a) XRD spectra of bare Si(111) and Ag islands grown at different Ag coverages and HIM images of Ag islands b) smaller islands (Ag coverage at 5 ML), c) larger islands (Ag coverage at 20ML)

References

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